Coupling Thermal Treatment with Microbial Reductive Dechlorination for the Enhanced Remediation of Chlorinated Ethenes

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Thermal treatment of sites contaminated with chlorinated solvents may improve the efficacy of simultaneous or subsequent bioremediation, helping to achieve remedial goals. However, the mechanisms by which thermal treatment influences microbial reductive dechlorination are not well understood. To explore the potential effects of thermal treatment on the growth and activity of dechlorinating microbial communities, a combination of batch and column studies was completed. Batch experiments were designed to identify and quantify relevant byproducts formed during thermal incubation (30 – 90 °C; 7 – 180 days) of natural soils, humic matter, and field soils (<0.01 – 63.81% wt. organic carbon), while column studies were conducted to assess the mobility and bioavailability of these byproducts in a flow-through system. Additional column experiments were completed to determine the impacts of low-temperature (35 – 50 °C) thermal treatment on the growth and activity of a tetrachloroethene-to-ethene dechlorinating consortium under continuous flow conditions. Batch and column study results indicate that heating of soils leads to release and transport downgradient of bioavailable organic acids (e.g., formate, acetate, propionate, butyrate), which support dechlorinating bacteria (e.g., *Geobacter lovleyi*, *Dehalococcoides mccartyi*) directly or following fermentation to hydrogen. Organic acid release generally increased with incubation temperature, incubation time, and soil organic carbon content. Data collected from column experiments indicate that the performance of a reductively dechlorinating bacterial consortium is enhanced during low-temperature thermal treatment: in a heated system (35 °C), 50 mg/L tetrachloroethene was reduced to vinyl chloride and ethene after 25 pore volumes (PV). In a similar system operating at a typical ambient groundwater temperature (15 °C), *cis*-dichloroethene was the primary constituent in the effluent after 52 PV. These findings demonstrate that thermal treatment of soils may support microbial reductive dechlorination by providing bacteria with a necessary carbon source and that even a modest temperature increase may enhance dechlorinator activity and ethene formation.

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